DARY'S DIARIE.

OR, THE

DESCRIPTION

and Use of a QUADRANT:

Whereby to find the Suns true Place, Right ascention, and Declination at all times of the Yeare.

AS ALSO,

The Houre of the Day, the Azimuth, the Houre of the Suns-Rising and Setting, and his Amplitude in all Latitudes.

With a *Sinicall Quadrant*, very usefull for Seamen (being applyed to plaine Sayling) and all others, that are Mathematically inclined.

By MICHAEL DARY, *Citizen of* London.

Devise of Man in working hath no end,
What one thought thinks another soone can mend.

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COVRTEOVS READER.

THou haſt here preſented to thy view, the deſcription and uſe of a portable Inſtrument, whereby thou mayeſt performe moſt of the neceſſary Queſtions that concerne *Trigonometria*, either Plane or Sphericall: But perhaps thou wilt judge it little worth, becauſe thou eſteemeſt, firſt the Authours credit to be ſmall, ſecondly, the Inſtrument it ſelfe to be obſcure and difficult. Thirdly, of litle uſe, becauſe the *Problemes* which are here laid downe, may be performed by the Canon of *Triangles* more Exactly. To which I

anſwer: firſt, though my owne credit
ſmall, yet this need not hinder thy goo
liking; Becauſe that this Inſtrume
was (in ſome ſort) projected (ſom
yeares ſince) by that worthy man M
Foſter in the deſcription of his Quadra
which was for the delineation of *Dialls*
Therefore of right to him the Inventio
belongs: But in this preſent Quadra
thoſe lines of his whereby he found t
Sunns *Azimuth* are continued, whereb
(as I conceive) they are more general
uſefull in *Spherical Trigonometria*; no
that I aſcribe any thing to my ſelfe, fo
I will not, nay, I dare not, being ſuc
an obſcure ſtarre, compare my ſelfe wit
ſo great a Luminarie; for I muſt nee
confeſſe, that the light that I received
this preſent Quadrant, was by comp
ring of Mr. *Foſters* Quadrant with th
fourth Axiome of *Pitiſcus* for ſpherica
Triangles, as it is rendered in Engliſh b
Mr *Hanſon*. Which Axiome I have ab
breviated & demonſtrated, for their ſake
that ſhall deſire a demonſtration of th

con

concluſions performed by this Inſtrument. Secondly, perhaps (at the firſt) thou wilt think this Inſtrument obſcure and difficult, but (I dare preſume) if thou art of a *Mathematicall* genius, thou wilt ſoone be able to perform any *Probleme* in the following diſcourſe, for I have to every *Probleme* put an *Example*, but *the Eaſieſt things may ſeeme hard at firſt*. But if there were a little more difficulty in this Quadrant then in others, wch are for perticular Latituds, me thinks the generality of this Quadrant might equalize the difficulty of it. Thirdly, I am not ignorant, that the *Problemes* in this diſcourſe may be performed more exactly by Calculation, yet not ſo ſpeedily as on the Inſtrument: But for obſervation an Inſtrument muſt be had, and (if thou like it) thou art here fitted with an Inſtrument, both for *obſervation* and *operation*. So deſiring thee to cover my faults with the mantle of love, I reſt.

Thine, in any friendly office.

MICHAEL DARY.

NOte that this *Inſtrument* or any other Mathematicall Inſtrument, either for Sea or Land, is exactly made in Braſſe or Wood, by *Henry Sutton* at Tower-hill neare the Poſterne-Spring.

To his loving Friend, MICHAEL DARY.

OF all the Arts *that ever yet was us'd,*
This Growing to it ſelfe makes that abus'd
And thou in this Art no way found to blame,
Which cauſeth thee remembred to thy fame;
Although brave Quadrants, *many there hath beene*
For generall vſe, the like I haue not ſeene:
When all is done ther's ſomething more remaynes,
For to bee added, by thoſe Curious braynes,
Which ſeeke perfection in anothers Act
Though they themſelues yet nothing will tranſ-act,
But thou deare friend, haſt an Heroick heart
To venture thus and bravely play thy part,
To give an on-ſet for a generall good,
In ſhewing That, *which may bee vnderſtood;*
But ſuch as write in darkneſſe little vſe
Can bee made of it, which is Arts *abuſe.*
I wiſh all ſuch that they forbeare to ſpoile
So much good Paper with ſuch fruitleſſe toyle.

M *any*

M *any will of it make now a good vse*
J *Meane that they this* Quadrant *first will chus*
C *arry on thy thoughts to practise but a while*
H *aving so good a* Guid, *he'le not thee beguile;*
A *nd thou shall find it vsefull at each Port,*
E *ls sure it shall bee none of thy Consort,*
L *et not thy will now sway thy Iudgement, lest*

D *owne thou shouldst fall to* Error *with the rest,*
A *nd there abide, vntill those Meanes seeme righ*
R *efused at first, but now proue such delight,*
Y *uough to thee; though others beare thee spight.*

I have Taken away ye Quadrant or rather I should say T. R. ye whole Figure which heere was inserted; & Pasted it on a Boarde:: G F ::

DARY

DARY'S DIARIE.

CHAP. I.

The Description of the fore-side of this Quadrant.

1.

HAving prepar'd a piece of Box or Brasse and thereon described a quarter of a Circle (as the usuall manner is,) Devide the Arch into 90 degrees, and number them from the left hand towards the right, this Scale is called *the Limbe*.

2.

That done, draw another quarter of a Circle concentricall upon the margent of the Limb, to represent a quarter of the *Ecliptique*, which to devide use this Proportion (the point of the Ecliptique being given which you would insert) As the Sine of 90. is to the Tangent of the distance of the given Point from the next Equinoctiall point; So is the Co-sine of the Suns greatest Declination to the Tangent of the fourth Arch; which Arch being numbered on the Limb, a right Line being extended from the center of the Quadrant to this arch in the Limb, will cut the Ecliptique where this given Point ought to be inserted.

M *any will of it make now a good vſe*
J *Meane that they this* Quadrant *firſt will chuſ*
C *arry on thy thoughts to practiſe but a while*
H *aving ſo good a* Guid, *he'le not thee beguile;*
A *nd thou ſhall find it vſefull at each Port,*
E *ls ſure it ſhall bee none of thy Conſort,*
L *et not thy will now ſway thy Iudgement, leſt*
D *owne thou ſhouldſt fall to* Error *with the reſt,*
A *nd there abide, vntill thoſe Meanes ſeeme righ*
R *efuſed at firſt, but now proue ſuch delight,*
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Then put on the Character for *Aries* ♈, on the right hand of 00. degrees *Taurus* ♉, on the right hand of 30 degrees *Gemini* ♊, on the right hand of 60. degrees *Cancer* ♋, on the left hand of 90 degrees *Leo* ♌, on the left hand of 60 degrees *Virgo* ♍, on the left hand of 30 degr *Libra* ♎, on the right hand of ♈, *Scorpio* on the right hand of ♉, *Sagitarius* on the right hand of ♊, *Capricornus* on the left hand of ♋, *Aquarius* on the left hand of ♌ and *Pisces*, on the left hand of ♍; then are the Signes put on according to their ſucceſſion in the Ecliptique. For ♈ ♉ ♊, are for the firſt quarter of the Ecliptique, ♋ ♌ ♍ for the ſecond quarter, ♎ ♏ ♐, for the third quarter ♑ ♒ ♓, for the laſt quarter.

3. Then let there be another quarter of a Circle deſcribed upon the margent of the Ecliptique to repreſent the Sunes *Declination*, which to devide, this is the Proportion (the point of Declination being given which you would inſert. As the Tangent of the Sunes greateſt Declination is to the Radius, ſo is the Tangent of the Declination of the Point given, to the Sine of the fourth Arch; Which fourth Arch being numbered on the Lymb, a right line from the center of the Quadrant to this arch in the Lymb, will cut the line of Declination where the given Point ought to bee inſerted.

4. Then at a ſmall diſtance from the Margent of the line of Declination deſcribe foure Concentrick circuler Scales and let them bee for *the foure Quarters of the Yeare*, accounting the loweſt for the firſt quarter, that next to it for the ſecond, &c. Setting the Names of the Moneths thereon in their order. Then having a Table of the Sunes right Aſcention for every Day of the yeare, extend a third from the Center of the Quadrant to the Right aſcention (repeating it forward and backward as need ſhall require) on the lymb anſwering to the Day required, and it will cut upon the quarter of the yeare [that anſwers to the repetition of the Limb] where that day ought to be inſerted.

5. Then

5. Then if you pleaſe to uſe it in but in one Latitude, you may put on the two other circuler Scales (which taken both together, wee call the rectified Scale.) Each having a double Margent, the uppermoſt Scale I call the Line of the ſumme, the lower the line of the Difference, and they are thus devided. Firſt, for the Scale of the Difference, let the beginning of it bee the Co-latitude of the place, for which you would rectifie it, and number it inverſedly, that is, decreaſe it by the Degrees and Min. of the Limb, in the next Margent to oo Deg. (which will fall juſt againſt the Co-latitude in ŷ lymb) And from oo. degrees, number it forward in the ſame margent and the Latitude will fall at the latter end: Then begin again, and let the beginning be the latitude, and number it forward in the remote margent, by the degrees and minutes of the lymb, and the latter end will be the ſumme of the Latitude, and a Quadrant.

Secondly, to devide the Scale of the ſumme. Let the beginning of it be the Co-latitude of the Place, for which you would rectifie it, and number it forward in the next margent, by the Deg. and Min. of the lymb, and the latter end will be the ſumme of the Co-latitude and a Quadrant. Then begin againe, and let the beginning be the Co-latitude and a Quadrant, and let it be numbered forward in the remote margent, by the the deg. and min. of the lymb, and the latter end, will be the ſumme of the Co latitude and a Semicircle.

6. All the ſpace betwixt the two Rayes and this rectified Scale, is a Sinicall quadrant, now in uſe amongſt Sea-men and others; each Ray being devided into 60 equall parts, and Paralels drawne there-from, croſſing each other at right Angles. And note that the Parallels that are numbered from the Center of the quadrant, toward the latter end of the Lymb, are (for diſtinction ſake) called *the Sinicall Parallels*, and thoſe that are numbred from the Center toward the beginning of the lymb, are called *the Co-ſinicall Parallels.*

CHAP. II.

Of the Description of the back-side of this Quadrant.

UPon the backside of this Quadrant, draw two right Lines crossing one the other in the Center at right angles, and paralell to the Edges, and describe a quarter of a Circle as large as the Quadrant will give leave, within which two Rayes and the Arch, there is (as you may see) three quarters of a *Rhumbus* inscribed, the fabrick whereof is thus; Let one of the Rayes of the Quadrant represent the Diameter of a Circle, or the versed Sine of 180 grades. And for the manner of the Division, doe thus.

Devide the Ray into two equall parts, then having a Diagonall Scale of 1000 Parts, equall to the one half of the devided Ray, you may (from the Table of *Naturall Sines*, the *Radius* being put 1000;) set off the Devisions thus. Take with your Compasses so many parts in your Diagonall Scale, as doe answer to the first three figures of the Sine of one degree, and transferre that distance from the Middle point of your devided Ray both wayes: Then againe, take with your Compasses so many Parts as doe answer to the first three figures of the Sine of two degrees, and transferre that Distance from the middle Point of your devided Ray both wayes; And thus you may doe with the first three figures of the Sine, of every respective degree of the Table.

This

This Ray being thus devided, number it from the Arch toward the center of the Quadrant; then may you call it *the double Radius*: Now take the Verted Sine of 90 Degrees (*viz.* one half of your devided Radius) with your Compasses, and insert it into the Quadrant, paralell to the double Radius; and let it bee devided into *Versed Sines*, like the first 90 degrees of the double *Radius*, and numbered the same way; and let this bee called *the single Radius*.

Now let there be Parallels drawne from these Devisions of the Single and double *Radiusses*, each to his like; also you must continue these Parallels of the last 90 Degrees from the double Radius, abutting on the other Ray of the Quadrant.

These Parallels may be called, the *Paralels of Sides*, because in them are reckoned the sides of a *spherical Triangle*, as shall hereafter appeare; and for their better distinction, you may prick the Paralell of every tenth Degree. Then devide the Paralell of 00 degree, and also of 90 degrees into *Versed Sines*, as you did the double Radius, numbering them at every 15.th degree, from the single Radius towards the double Radius.

Now let there bee Parallels drawne through these Devisions, abutting on the other Ray of the Quadrant; these Parallels may be called, the *Parallels of Angles*; for that by them are measured the Angles of a Sphearicall Triangle; and for their better distinction prick every 15.th Degree.

And Note, that the Intersection of the two Parallels of 90 *Sides* and *Angles*, is called the *Center* of the *Rhumbus*.

To this Quadrant as to all others of this kind in their Vse, there is added *sights*, with a Thrid, Bead and Plummet, which thrid is of sufficient length, to goe through the Center to bee used on the backside the Quadrant.

CHAP. III.

Of the Vſe of the fore-ſide of this Quadrant.

THe uſe of the Lymbe, is for obſervation of all neceſſary Angles, as is ſufficiently knowne to every Practitioner, as —

PROBLEME, I.

To find the Suns Altitude.

HOlding the Superficies of the Quadrant perpendiculer to the Horizon, and the beginning of the Lymb towards the Sunne, let the Sunne beames paſſe through both the ſights at once, and the thrid will cut upon the lymb the degree of the Sunnes height.

Example.

Vpon the 11.th of *March*, in the Latitude of 51 deg. 30 minutes, holding the Superficies of the quadrant perpendiculer to the Horizon, and the beginning of the lymb towards the Sun, (about 12 of the clock) I let the Sun-beames paſſe through both the ſights at once, and the thrid cuteth upon the lymb, about 38 deg. 30 min. for the Meridian altitude there.

PROB. 2.

PROB. 2.

The day of the Moneth being given, to find the Sunnes right Aſcention, his true Place and Declination.

EXtend the thrid from the Center of the Quadrant upon the Day of the Moneth, and it will ſhew upon the lymbe, (being repeated with the quarter of the yeare) his Right aſcention. Vpon the Ecliptick (reckoning according to the order of the *Signes*) his true Place. And upon the Line of Declination (obſerving that if the Sunne be in the Northerne ſignes, as ♈ ♉ ♊ ♋ ♌ ♍, his Declination is North. But if in the Southerne ſignes, as ♎ ♏ ♐ ♑ ♒ ♓, his Declination is South) his Declination.

Example.

The 10.th of *January* I deſire all that is aboveſaid, I extend the thrid from the center upon the 10.th of *January*, and I find it to ſhew upon the lymbe 302 gr. 45 min. (being repeated three times, and going the fourth) his right Aſcention; and upon the Ecliptick it cutteth 00 gr. 59 min. of ♒, (being reckoned according to the order of the Signes) his true Place: and on the line of Declination (becauſe the Sunne is in the Southerne ſignes) it ſhewes 20 gr. 06 min. South.

PROB. 3.

To find the Houre of the Night.

OBſerve when any knowne *Starre* commeth to the Meridian, and if the Right aſcention of the Sunne be more then that of the Starre, the difference of Aſcentions being reduced into time, it is ſo much

much paſt 12 of the clocke at Noone; but if the Right aſcention of the *Sunne* be leſſe then the *Starre*, it wanteth ſo much of 12 at Noone.

Example.

The 10 th of *January*, I find the Sunnes right aſcention to bee 302 gr. 45 min. Now ſuppoſe I made obſervation, and find *Arcturus* to be directly in the Meridian, whoſe right Aſcention is 210 grades, then I find the Difference of aſcention to be 92 gr. 45 min. Which reduced into time is 6 Houres 11 Minutes.

Then I ſay, becauſe the Right aſcention of the Sun is more then the right aſcention of *Arcturus*, it is ſix houres and 11 minutes paſt 12 at Noone. But becauſe you may readily find the houre of the Night, I will inſert this Table of the Right aſcentions of the five Starres

	Hou. M.	Decl. M.
Pegaſus Wing, ——	23. 59	13. 15.
Arcturus, —— ——	14. 00	21. 04.
Lyons Heart, ——	09. 48	13. 39.
Bulls Eye, —— ——	04. 16	15. 46.
Vultures Heart, ——	19. 34	08. 00.

uſed by Mr. GUNTER, in the *Deſcription of his Quadrant*, ready reduced to Time, which may ſerve for uſe on the North ſide of the Equinoctiall; but for thoſe of the Southerne conſtellations, you may fit your ſelfe by the Table in Mr. NORWOOD's *Epitome*.

PROB. 4.

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The Sunnes true Place being given, to find the Day of the Moneth.

EXtend the thrid from the center of the Quadrant, to the Sunnes true Place on the Ecliptick, and it will shew upon the quarter of the Yeare (that belongeth to that quarter of the Ecliptick, in which the Sun is) the Day of the Moneth; reckoning according the order of the Moneths.

Example.

The Sunnes true Place being given, 00 gr. 59 min. ♒. I would know the Day of the Moneth, I extend the thrid from the Center of the quadrant, upon minutes of *Aquarius*, and I find it to Cut on the first quarter of the yeare (because the Sun is in the last quarter of the Ecliptick) the 10.th Day of *January*, reckoning according to the order of the Moneths.

PROB. 5.

To find the Sunnes distance from the Pole.

HAving found the Sunnes Declination, if it bee South, adde the Declination to 90 grades, and if it bee North, subtract it from 90 gr. gives the Sunnes distance from the Pole.

Example.

When the Sunne hath 20 gr. 6 min. South Declination, I would know the Distance from the Pole; now becauſe

becauſe the Declination is South, I adde it to 90. g
maketh 110 gr. 6. min. for the Sunnes diſtance fro
the Pole required.

Now I ſhall ſpeake of the vſe of the Recti
fyed Scale.

This Scale ſerveth readily to find the Summe an
Difference of Two ſides of a *Sphearicall Triangle*, one
them being 38 gr. 30 min. as it is rectified for the L
titude of *London*, 51 gr. 30 min.

PROB. 6.

Two ſides of a Sphearicall Triangle *being gi*
ven, one of them being 38 *gr.* 30 *min. th*
other not exceeding 90 *Gr. To find the*
Summe and Difference.

EXtend the Thrid from the center of the Quadran
to that other ſide in the degrees upon the Lymb
and the thrid will ſhew on the Line of the ſumm
their ſumme, and on the line of the Difference, the
Difference; in the next Margents.

Example.

I would know the ſumme and difference of theſe tw
ſides of a Sphericall Triangle 38 gr. 30 min. and 54 g
and I extend the thrid from the Center of the quadran
to 54 gr. in the lymb, and it Cutteth on the line of th
ſumme 92 gr 30 min. and on the line of the differenc
15. gr. 30 min. in the next margents.

PROB. 7

PROB. 7.

Two ſides of a Sphearicall Triangle *being given, one of them being* 38 *Gr.* 30 *Min. and the other exceeding* 90 *Degrees, to find their Summe and Difference.*

EXtend the thrid from the Center of the quadrant to the exceſſe of that other ſide in the degrees upon the lymb and it will cut vpon the line of the Summe, their Summe, and vpon theline of the Difference, their Difference in the remote Margents.

Example.

I would know the Summe and Difference of theſe two ſides of a ſphearicall Triangle, 38. gr. 30 min. and 144. gr. I extend the thrid from the center of the Quadrant to the exceſſe, of that other ſide in the degrees vpon the limb, and it cutteth on the line of the Summe 182 gr. 30 min. and on the line of the Difference 105 gr. 30 min. in the remote Margents.

Laſtly, of the uſe of the Sinicall quadrant, (of which I ſhall ſpeake very briefly in regard the uſe of it is common amongſt Seamen, and it is put on this Inſtrument to fillup a vacant place.) It ſerveth in ſtead of a Table of Sines (the Radius or ſine of 90 degrees being put 60; but for the more Exactneſſe, wee will ſuppoſe it to be 600 equall parts] readily to find the ſine of any Arch under a Semicircle, for this you muſt note, that every right Sine is the ſine of two Arches, one of them being the Complement of the other to 180 degrees. Therefore if it were required of you to give the ſine of 130 degrees, you may give the ſine of 50 deg. which is the common Sine to both thoſe Arches.

PROB. I.

PROBLEM, I.

To find the Sine and Co-sine of any Arch given, the Radius being put 600.

EXtend the thrid from the Center of the Quadrat to the Arch given on the Lymb, and where th thred cutteth the arch of the Synicall quadran there you have the Sine in the sinicall Paralels: an the Co-sine in the Co-sinicall Paralels.

Example.

I would have the Right sine and Co-sine of 30 de grees. Therefore I extend the thred from the center o the Quadrant, to the arch given 30 degrees in the limb and where the thrid cutteth the Arch of the sinical Quadrant, there I find the sine in the sinicall parralel to be 300, and the Co-sine in the Co-sinicall parelle to be 520. *viz*: the sine of 60 Degrees.

PROB. 2.

To find the Arch of any Sine given, the Radius being put 600.

ACcount the Sine given in the sinicall Parallels then move the thrid to the point of Intersection that the Paralle l of the sine given, maketh with the arch of the sinicall quadrant, and the thrid shewet upon the lymb the Arch required.

Example

Example.

I would know the Arch belonging to 300. the Radius being put 600. Therefore I account the ſine given 300 on the ſynicall Parallels. Then I move the thrid to the point of Interſection, that the Paralell of the ſine given 300, maketh with the Arch of the ſynicall quadrant, and the thrid ſheweth upon the lymb the Arch required to be 30 degrees.

Now that you can readily diſcover the Sine of any Arch, you may proceed to the reſolution of *Triangles* by the Sines ſo found, being wrought according to the Rules in each caſe provided, and you may come neare enough to the truth, in buſineſſes that are not of any great Conſequence; but for this purpoſe, the Radius would have been more convenient, if it had been put into Decimall parts, as 100, or 1000; but [as I ſaid before] in regard it is commonly uſed in the ſame forme as here you find it, I will paſſe it by. My intent is at this time onely, to ſhew how to work thoſe Caſes in plaine *Trigonometria*, that are agreeable to this Axiome: *In all plaine Triangles the ſides are directly proportionall to the Sines of their oppoſite Angles.*

Therefore in a plaine Triangle if two ſides, with the angle oppoſed to one of them be given, the Angle oppoſed to the other is diſcoverable by the rule of Proportion; or if two Angles with the ſide oppoſed to one of them be given. the ſide oppoſed to the other may be found by Proportion. Therefore it will be requiſite to ſhew how,

PROB. 3.

PROB. 3.

To worke the rule of Proportion in plaine Trigonometria (viz. *To worke the proportion of the ſines of the Angles, to their oppoſite Sides, or of the ſides, to the Sines of their oppoſite angles*) *upon the ſinicall Quadrant.*

IN the working of this Problem, there are two caſes, viz: Firſt either the three terms given, are two Sines with one ſide, and the fourth terme demanded a ſide: or two ſides with one Sine, and the fourth terme demanded a Sine.

In the firſt caſe, when the three terms given are two ſines with one ſide, and the fourth terme demanded a ſide, obſerve this Precept.

Extend the thrid from the Center of the quadrant to the degrees and minutes of the firſt Sine given on the limb, and ſet the Bead to the number of parts of the ſide given, in the ſynicall Parallels [but if the number of parts of the ſide given, reach beyond and the firſt ſine, you muſt take that number of leſſer parts by dividing each part leſſe, as into 2, 3, or 10. as you pleaſe till the number of the parts of the ſide given fall ſhort of the firſt Sine, the figures belonging to the ſinicall Parallels being valued accordingly] Then move the thred to the degrees and minutes of the ſecond ſine on the limb, and the bead will ſhew in the ſynicall Parallels, the number of like parts in the ſide required, which is the fourth terme demanded.

In the ſecond caſe, when the three termes given are two ſides with one ſine, and the fourth terme demanded a ſine, do thus:

Extend the thred from the center of the Quadrant to Deg. and min. of the ſine given on the limb, and ſet the

ead

Bead to the number of parts of the first side given in the ſynicall Parallels [obſerving the caution in the firſt caſe] Then move the thred till the bead fall upon the number of like parts of the ſecond ſide given in the ſynicall Parallels, and the thred will ſhew on the lymb, the degrees and minutes of the ſine required, which is the fourth terme demanded.

Example, 1.

I Would work this proportion on the ſinicall Quadrant
As the Sine of 35. 30 min. is to the 50. ſide.
So is the Sine of 60. 30 min. to another ſide.

Therefore I extend the thrid from the center of the Quadrant to 35. 30. on the Limb [now becauſe 50 reacheth beyond the ſine of 35. gr. 30 min. in the ſynicall parallels, I take 50 in leſſe parts, and for every $\frac{1}{2}$ I reckon 1. in the ſynicall Parallels, and accounting after this manner, I find my 50, to be repreſented at 25 in the ſynicall Parallels, ſo that the figures of the ſynicall Parallels [in the working of this Example] are double their owne value, for the whole number of ſuch parts that are in the ſynicall Parallels are 120] and I ſet the bead to 50 [*viz.* 25] Then I move the thrid to the deg. and minutes of the ſecond ſine 60. 30 min. and the Bead ſheweth in the ſynicall Parallels, the number of like parts in the ſide required to be 75. which is the fourth terme demanded.

Example, 2.

I Wouldworke this Proportion on the ſynicall quadrant
As 75. is to the ſine of 60. gr. 30. min.
So is 50. to another ſine.

Therefore I extend the thrid from the Center of the Quadrant to 60. 30 min. on the lymb, and ſet the bead to 75. (*viz.* 37 $\frac{1}{2}$) obſerving the caution in the firſt Example] then I move the thrid till the Bead fall upon 50. of the like parts in the ſinicall Paralels, and the thrid

thrid ſheweth on the lymb the Degrees and Minutes
the Sine required, to bee 35 gr. 30 min. which is th
fourth terme demanded.

This to the ingenious may ſuffice; for being we
underſtood, I ſhall not need to repeat the ſame again
to the ſubſequent *Problemes*, which are for the ſolutio
of Nauticall Queſtions, performed according to th
plaine Sea-chart.

The projection of this Chart, doth in ſome ſo
repreſent the Spheare in *plano*; for firſt, there is a righ
Line drawne divided into 360 equall parts, to repreſe
the Equinoctiall, and all the Circles of the Sphear
whoſe Poles are in the Equinoctiall [*viz.* all Mer
dians] are right lines drawne at right Angles throug
the diviſions of the Equinoctiall at right angles. An
all the Circles of the Spheare, whoſe Poles are the ſam
with the Poles of the Equinoctiall [*viz.* all Paralels
latitude] are right lines drawne at right angles croſſin
the Meridians. And although that this Projection b
not exactly true [for that the Parallels of Latitude an
their degrees are equall to the Equinoctiall, and th
Meridians and their degrees] yet it is of uſe for ſho
Voyages, becauſe of the facility thereof.

Now before wee proceed to the Queſtions that a
performed according to this Projection, wee muſt no
the parts by which diſtances of Places are uſually me
ſured, which are Degrees, Leagues, and Miles. And
degrees there are contained on the whole Chart 36
Every degree is 60 leagues, and every league is
Miles.

Moreover, wee muſt note the quantity of the Angle
whereby the bearing of one Place from the Meridia
of another, is uſually accounted; which are Points
the Compaſſe [or Rhombs] Degrees and Minutes;
very Point is 11. 15. and every Degree is 60 Minutes
As you may ſee in this Table.

A Tabl

able of *Rhumbes*; that is, how many Degr.
d Minutes, are intercepted betweene the Meridian
d every Point, half-Point, and quarter-Point, of one
rth part of the Compasse.

rth	South	D. M.	South	North	
		2 49			
		5 38			
		8 26			
E.	S by E.	11 15	S by W.	N by W.	1
		14 04			
		16 53			
		19 41			
E.	S S E.	22 30	S S W.	N N W.	2
		25 19			
		28 8			
		30 56			
by N.	S E by S.	33 45	S W by S.	N W by N.	3
		36 34			
		39 23			
		42 11			
E.	S E.	45 00	S W.	N W.	4
		47 49			
		50 37			
		53 26			
by E	S E by E.	56 15	S W by W	N W by W	5
		59 4			
		61 52			
		64 41			
E,	E S E.	67 30	W S W.	W N W.	6
		70 19			
		73 7			
		75 56			
E by N.	E by S.	78 45	W by S,	W by N.	7
		81 34			
		84 22			
		87 11			
East.	*East.*	90 00	*West.*	*West.*	8

thrid sheweth on the lymb the Degrees and Min
the Sine required, to bee 35 gr. 30 min. which
fourth terme demanded.

This to the ingenious may suffice; for being
understood, I shall not need to repeat the same
to the subsequent *Problemes*, which are for the so
of Nauticall Questions, performed according
plaine Sea-chart.

The projection of this Chart, doth in som
represent the Spheare in *plano*; for first, there is a
Line drawne divided into 360 equall parts, to rep
the Equinoctiall, and all the Circles of the Sp
whose Poles are in the Equinoctiall [*viz.* all
dians] are right lines drawne at right Angles th
the divisions of the Equinoctiall at right angles
all the Circles of the Spheare, whose Poles are th
with the Poles of the Equinoctiall [*viz.* all Para
latitude] are right lines drawne at right angles c
the Meridians. And although that this Projecti
not exactly true [for that the Parallels of Latitu
their degrees are equall to the Equinoctiall, a
Meridians and their degrees] yet it is of use for
Voyages, because of the facility thereof.

Now before wee proceed to the Questions th
performed according to this Projection, wee mu
the parts by which distances of Places are usuall
sured, which are Degrees, Leagues, and Miles. A
degrees there are contained on the whole Chart
Every degree is 60 leagues, and every leagu
Miles.

Moreover, wee must note the quantity of the A
whereby the bearing of one Place from the Me
of another, is usually accounted; which are Po
the Compasse [or Rhombs] Degrees and Minutes,
very Point is 11. 15. and every Degree is 60 Minutes.
As you may see in this Table.

A Table

A Table of *Rhumbes*; that is, how many Degr. and Minutes, are intercepted betweene the Meridian and every Point, half-Point, and quarter-Point, of one fourth part of the Compasse.

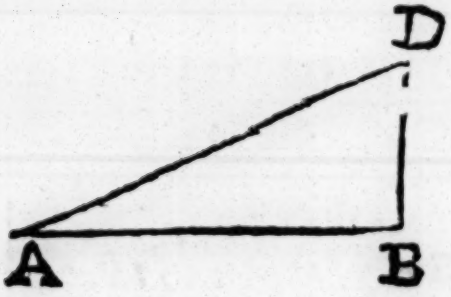
North	*South*	D.	M.	*South*	*North*	
			2 49			
			5 38			
			8 26			
N by E.	S by E.	11	15	S by W.	N by W.	1
			14 04			
			16 53			
			19 41			
N N E.	S S E.	22	30	S S W.	N N W.	2
			25 19			
			28 8			
			30 56			
N E by N.	S E by S.	33	45	S W by S.	N W by N.	3
			36 34			
			39 23			
			42 11			
N E.	S E.	45	00	S W.	N W.	4
			47 49			
			50 37			
			53 26			
N E by E	S E by E.	56	15	S W by W	N W by W	5
			59 4			
			61 52			
			64 41			
E N E,	E S E.	67	30	W S W.	W N W.	6
			70 19			
			73 7			
			75 56			
E by N.	E by S.	78	45	W by S,	W by N.	7
			81 34			
			84 22			
			87 11			
East.	*East.*	90	00	*West.*	*West.*	8

PROBLEM, 4.

To find the Rhumbe, the Diſtance of two Places, with their difference of Latitudes being given.

AS the Diſtance is to the Sine of 90, ſo is the difference of Latitudes to the ſine of the Complement of the Rhumbe required.

Example.



Let the two Places given bee *D* and *A*, their Diſtance *D A*, 120 Leagues, *D* being in the Latitude of 51 deg. 30 min. and *A* in the Latitude 50 deg. 00 min. Then is their difference of Latitude *D B*, 1 deg. 30 min. that is 30 leagues.

Then I ſay,

As the Diſtance *D A*, 120 Leagues.
Is to the ſine of 90 Degrees the angle at *B*.
So is the difference of Latitude *D B*, 30 leagues.
To the ſine of the Complement of the Rhumbe 14 d
(30 min. the angle at *A*

Then is the Rhumbe the angle at *D*, 75 deg. 30 min. that is, 6 Points 8 degrees, the bearing of *A* from the Meri

Meridian of *D*, either Eaſtward or Weſtward, accor-ding to the ſcituation of the Place *A*.

PROB. 5.

To find the Difference of Latitude of two Places, the Rhumbe and Diſtance on the Rhumbe being given.

AS the Sine of 90 degrees is to the Diſtance, ſo is the ſine of the Complement of the Rhumbe to the Difference of Latitude required.

Example.

Let the two Places given bee *A* and *D*, [as before] the Rhumbe 75 deg. 30 minutes, I ſay
As the Sine of 90 deg. the angle at *B*.
Is to the Diſtance *A D*, 120 Leagues;
So is the ſine of the Complement of the Rhumbe 14 (deg. 30 min. the Angle at *B*.
To the Difference of Latitude *D B*, 30 Leagues.

PROB. 6.

To find the Diſtance of two Places, the Rhumbe and Difference of Latitude being given.

AS the ſine of the Complement of the Rhumbe, is to the Difference of Latitude, ſo is the Sine of 90 deg. to the Diſtance required.

Example.

Let the two Places be *A* and *D*, and their Difference of Latitude *D B*, 30 leagues, and the Rhumbe the angle at *D*, 6 Points 8 degrees, that 75 deg 30 min. I say,

As the sine of the Complement of the Rhumbe 14 [deg. 30 min. the Angle at *A*.
Is to the Difference of Latitude *D B*, 30 leagues;
So is the Sine of 90 deg. the Angle at *B*.
To the Distance *A D*, 120 leagues.

PROB. 7.

To find the Departure from the Meridian, the Rhumbe and distance on the Rhumb being given.

AS the Sine of 90 degrees is to the Distance on the Rhumbe, so is the sine of the Rhumbe to the Departure from the Meridian required.

Example.

As admit I am to sayle from *D* to *A*, the Distance *A D*, being 120 Leagues, and the Rhumbe the angle at *D*, 6 Points 8 degrees, that is 75 deg. 30 min.

I say,

As the Sine of 90 Degrees the angle at *B*.
Is to the Distance on the Rhumbe *A D*, 120 leagues
So is the sine of the Rhumb 75.d.30.m. ÿ angle at *D*
To the departure from the Meridian [of *D*] *A B* (116 leagues

PROB. 8.

PROB. 8.

FUrther, the uſe of the *Synicall Quadrant*, is to find the Proportion of the leſſer Circles deſcribed on the Spheare to the greater, as

To find how many Minutes or Miles in any Paralell to the Equinoctiall, doe anſwer to 1 *deg. of the Equinoctiall.*

EXtend the thrid from the Center of the Quadrant on the Limb, to the Parllels diſtance from the Equinoctiall [*viz.* The Latitude] and where the thrid cutteth the Arch of the Sinicall Quadrant, there is the Number of Miles anſwering to one degree of the Equinoctiall, in the Co-ſinicall Paralels.

Example.

I would know how many Miles in the Latitude of 51 gr. 30 min. to anſwere to one degree of the Equinoctiall. Therefore I extend the thrid from the Center of the Quadrant to 51 gr. 30 min. in the Limb, and where it cutteth the Arch of the Sinicall Quadrant, I find [in the Co-ſynicall Parallels] $37\frac{4}{18}$. which is the number required.

The uſe of this Synicall quadrant may be further manifeſted in the taking of *Heights*, viz. the meaſure of ſuch things as ſtand perpendicular to the plane of the Horizon, as Trees, ſteeples, and Towers &c. And note that the diſtance betwixt the foote of the object and your ſtation is called *the Baſe*, becauſe it is equall to the right Line betwixt your Eye and the Point in the object levell

with your Eye, which is the true Baſe. And the right Line [imagined] betwixt your eye and the top of the object is the *Hypothenuſa*: alſo the perpendicular let fall from the top of the object to the Superfices of the Earth on the Horizontall plane, whereon you ſtand, is the true Height, and ſo much of that perpendicular as is above the levell of your Eye, is the Height that wee doe hereafter make mention [moreover the Angle at the top of the object is called the *verticall Angle*, and the Angle at your eye is called *the accute angle*, at the Baſe or the Complement of the Verticall Angle.

PROB. 9.

To find the Height of an object acceſſible.

FIrſt, at a convenient Diſtance chooſe your ſtation, then holding the ſuperficies of the Quadrant perpendicular to the *Horizon*, and the beginning of the Limb toward the object (the Plumb line hanging at full liberty] lift up the Quadrant till you perceive the top of the object through both the ſights, and note the Degrees cut on the limb; for ſo much is the accute Angle at the Baſe, whoſe Complement to 90 degrees, is the Verticall Angle. 2. Meaſure the diſtance betwixt the foot of the object and your ſtation. 3. Then ſay as the ſine of the Verticall Angle is to the baſe [or diſtance meaſured] ſo is the ſine of the Complement of the verticall, to the Height required.

Example.

Let B D be the height of the Steeple that I would meaſure. Firſt chooſing out a convenient ſtation, as at *A*, I make obſervation, and find the Verticall angle A D B.

A D B, to bee 60 gr. and the Accute angle at the Baſe B A D 30 degrees.

Secondly, I meaſure the Diſtance betwixt the foot of the Object *B*, and my ſtation *A*, which I find to bee 40 Paces.

Thirdly, then I ſay,
As the Sine of the Verticall angle *A D B*, 60 degr.
Is to the Baſe *A B*, 40 Paces.
So is the Sine of the Complement of the Verticall (angle *D A B*, 30 degrees.
To the Height required *B D*, 23 $\frac{1}{17}$ Paces.

PROB. 10.

To find the Height of an object inacceſſible.

FIrſt, as farre off your Object as you may conveniently chooſe your ſtation, and by the laſt *Probleme* find the Verticall angle. Which you may call the firſt *Verticall Angle*.

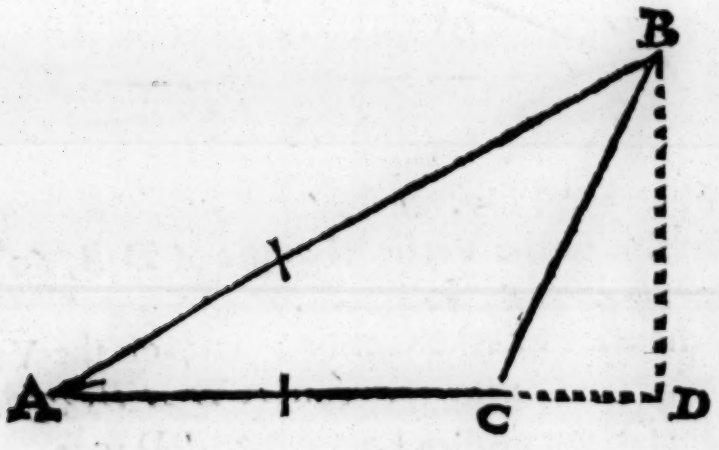
Secondly, meaſuring forward in a right Line toward the Object, approach as neare as you can, and then doe as you did at your firſt ſtation to find the Verticall

angle ; which you may call the ſecond Vertical angle.

Thirdly, then ſay, As the ſine of the Difference of the Verticall angles is to the Diſtance meaſured, ſo the ſine of the Complement of the firſt Verticall angle to the ſecond *Hypothenuſa.*

Fourthly, againe as the Sine of 90. is to the ſecond Hypothenuſa, ſo is the ſine of the Complement of the ſecond Verticall angle to the Height required.

Example.



Let *B D*, bee the height of a Steeple, and let *C D* be the bredth of a River, or ſome obſtacle betwixt the object and mee. Firſt, I chooſe out a convenient ſtation, as farre off as I can, as at *A*; and by obſervation I find the Verticall *A B D*, to bee 60 degrees, which I call the firſt Verticall angle.

Secondly, meaſuring in a right Line toward the Object, I approach as neare as I may, which is at the Point *C*, finding *A C* to bee 29 Paces ; Then I make obſervation againe, and find the Verticall angle *C B D*, to bee 25 deg. 30 min. for the ſecond Verticall angle. Then I ſay,

Thirdly,

Thirdly, as the Sine of the difference of the Verticall (angles *A B C*, 34 deg. 30 min.
Is to the Diſtance meaſured *A C*, 29 Paces.
So is the ſine of the Complement of the firſt Verticall (angle *B A C*, 30 degrees;
To the ſecond Hypothenuſa *B C*, 25 $\frac{1}{2}$ Paces.

Fourthly, as the Sine of 90 degrees the Angle at *D*.
Is to the ſecond Hypothenuſa *B C*, 25 $\frac{1}{2}$ Paces.
So is the ſine of the Complement of the ſecond Ver. (ticall angle *B C D*, 64 deg. 30 min.
To the Height required, 23 $\frac{7}{15}$ Paces.

CHAP. IV.

IN the next place [before I come to ſhew the vſe of the backſide] I ſhall ſpeake ſomething concerning the 4. th *Axiome* of the 4. th of *Piti ſcus*, becauſe it is the foundation thereof, which *Axiom* reſolueth two Caſes of a Spherical Triangle, *firſt* Three ſides beeing given to find an Angle. Second Two ſides and the Angle concluded by them being given, to find the third ſide, [which according to Mr. *Hanſons* tranſlation] is thus. In all Spherical Triangles if firſt you adde two ſides together, either of them leſſe then a Quadrant, and then adde the leſſer ſide to the Complement of the greater ſide, and if your ſubtract the ſine of the Complement of the former Compoſed Arch, from the ſine of the latter Compoſed Arch, or if you adde it to the ſine of the exceſſe, then as the Radius is to the halfe of that right Line ſo made, either by

by addition or ſubtracted, ſo is the Verſed ſine of th Angle comprehended of the ſaid two ſides to a righ Line, which ſubtracted from the ſine of the latte compoſed arch, leaveth the ſine of the Complement o the third ſide, or from whence the ſine of the latte compoſed arch ſubtracted, leaveth the ſine of th exceſſ. of the third ſide.

Or contrarily, as the ſ. of that right Line is to th Radius, ſo is the right line made of the ſine of the latte compoſed Arch, either by ſubtraction of the ſine of the Complement of the third ſide, or by addition of the ſine of the exceſſe of the ſame third ſide, to the verſed ſine of the Angle comprehended of the other two ſides.

Which Axiome I haue abbreviated for the more facile working on this Quadrant, for whereas *Pitiſcus* worketh by the Right ſines I worke by the Verſed: Therefore I would give you a hint of the definition of a *Verſed ſine.*

The Verſed ſine of an Arch is the Segment of the Diameter, drawne from one end of that Arch till it be cut by a perpendiculer from the other end of the ſaid Arch. Now according to this definition, [I ſay of the verſed ſines, as *Pitiſcus* of the right Sines] The verſed ſine of an Arch more or leſſe then a Semicircle is one and the ſame right Line, as in the figure following, I ſay the right line B S, is the Verſed ſine of the arch B G, by letting fall the perpendiculer G S. Alſo I ſay the ſame right line B S, is the verſed ſine of the arch B G D R, which doth as much exceed the Semicircle B G D, as the arch B G doth fall ſhort of it. I thought good to premiſe this, leaſt when there had happened an Arch more then 180 gr. in the vſe of the ſucceeding *Axiome*, a beginner might haue beene put to a *Non-plus.*

Now I ſhall deliver the Axiome in theſe words.

In

In all Sphearicall Triangle: as the Difference of the Verſed ſines of the Summe, and of the Difference of any two ſides (including an Angle) is to the Diameter; ſo is the Difference of the Verſed ſines of the third ſide, and of the Difference of the two including ſides, to the Verſed ſine of the Angle comprehended of the ſaid two Sides. Or contrarily. *As the Diameter is to the Difference of the verſed Sines of the ſumme, and of the difference of any two Sides (including an Angle,) ſo is the Verſed ſine of the Angle, comprehended of the two ſaid Sides, to the Difference of the Verſed ſines of the third Side, and of the difference of the two including Sides. Which Difference being added to the Verſed ſine of the Difference of the two including Sides, you have the Verſed ſine of the third ſide.*

Now according to this *Axiome*, I ſhall ſhew you the proportion *Geometrically*, by laying downe a Circle repreſenting the *Spheare*.

Then I ſay, let there bee a Circle deſcribed, as *A B E D A*, and let it repreſent the Meridian; alſo let *A*, repreſent the *Zenith*; *E* the *Nadir*, *A E* the verticall *Circle* of Eaſt and Weſt; let *B* repreſent the *Pole Articke*, *D* the *Pole Antarticke*, and *B D* the Houre-circle of ſixe, or the *Axis* of the *Spheare*; then ſhall *A B* bee the Co-latitude of the Place (the Spheare beeing thus rectified) alſo let *A G*, *A C*, and *A H*, each of them be the Co-altitude, or the Suns diſtance from

by addition or ſubtracted, ſo is the Verſed ſine of th Angle comprehended of the ſaid two ſides to a righ Line, which ſubtracted from the ſine of the latte compoſed arch, leaveth the ſine of the Complement o the third ſide, or from whence the ſine of the latte compoſed arch ſubtracted, leaveth the ſine of th exceſſe of the third ſide.

Or contrarily, as the ſ. of that right Line is to th Radius, ſo is the right line made of the ſine of the latte compoſed Arch, either by ſubtraction of the ſine of the Complement of the third ſide, or by addition of the fine of the exceſſe of the ſame third ſide, to the verſed ſine o the Angle comprehended of the other two ſides.

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The Verſed ſine of an Arch is the Segment of the Diameter, drawne from one end of that Arch till it be cut by a perpendiculer from the other end of the ſaid Arch. Now according to this definition, [I ſay of the verſed ſines, as *Pitiſcus* of the right Sines] The verſed ſine of an Arch more or leſſe then a Semicircle is one and the ſame right Line, as in the figure following, I ſay the right line B S, is the Verſed ſine of the arch B G, by letting fall the perpendiculer G S. Alſo I ſay the ſame right line B S, is the verſed ſine of the arch B G D R, which doth as much exceed the Semicircle B G D, as the arch B G doth fall ſhort of it. I thought good to premiſe this, leaſt when there had happened an Arch more then 180 gr. in the vſe of the ſucceeding *Axiome*, a beginner might haue beene put to a *Nonplus.*

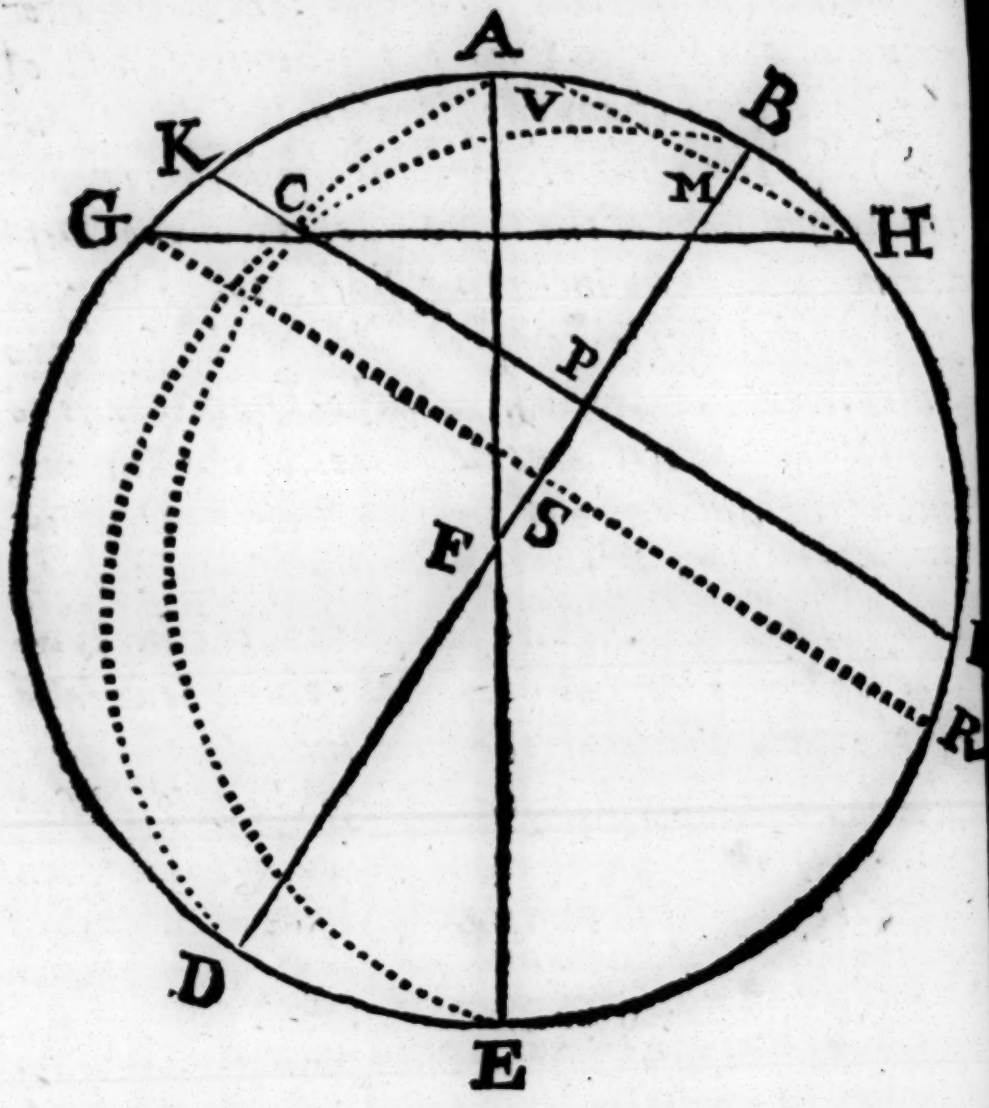
Now I ſhall deliver the Axiome in theſe words.

In

In all Sphearicall Triangle: as the Difference of the Verſed ſines of the Summe, and of the Difference of any two ſides (including an Angle) is to the Diameter; ſo is the Difference of the Verſed ſines of the third ſide, and of the Difference of the two including ſides, to the Verſed ſine of the Angle comprehended of the ſaid two Sides. Or contrarily. *As the Diameter is to the Difference of the verſed Sines of the ſumme, and of the difference of any two Sides (including an Angle,) ſo is the Verſed ſine of the Angle, comprehended of the two ſaid Sides, to the Difference of the Verſed ſines of the third Side, and of the difference of the two including Sides. Which Difference being added to the Verſed ſine of the Difference of the two including Sides, you have the Verſed ſine of the third ſide.*

Now according to this *Axiome*, I ſhall ſhew you the proportion *Geometrically*, by laying downe a Circle repreſenting the *Spheare*.

Then I ſay, let there bee a Circle deſcribed, as *A B E D A*, and let it repreſent the Meridian; alſo let *A*, repreſent the *Zenith*; *E* the *Nadir*, *A E* the verticall *Circle* of Eaſt and Weſt; let *B* repreſent the *Pole Articke*, *D* the *Pole Antarticke*, and *B D* the Houre-circle of ſixe, or the *Axis* of the *Spheare*; then ſhall *A B* bee the Co-latitude of the Place (the Spheare beeing thus rectified) alſo let *A G*, *A C*, and *A H*, each of them be the Co-altitude, or the Suns diſtance from



from the *Zenith*, and let *B K*, *B C*, and *B L*. each of them bee the Co-declination, or the Suns distance from the *Pole articke*. These things being thus laid downe, [I say] let the Triangle *A B C*, bee given, whose sides *A B*, *A C*, and *B C*, are knowne, and let the angle *C A B*, bee required. I say *B G*, is the Summe of the sides A B, and A C. For A G equall to A C, is put to *A B*, but if equall things bee put to equall, their totall shall bee equall, therefore I say the arch *B G*, is the

summe

ſumme of the two including ſides *A B*, and AC. Now the verſed ſine of this arch *B G*, is the right line *B S*, by the definition of a verſed ſine, which is by the falling of the perpendiculer *G S R*, vpon the Diameter *B D*, *Petiſcus* 2. and the 13th.

Againe, I ſay BH, is the difference of the ſides A B, and A C. For A H equall to A C. hath A B taken away from it, but if equall things are taken from equall, equall ſhall remaine; therefore I ſay the arch B H, is the remayner or difference of the two including ſides A B and A C. Now the verſed ſine of this arch B H, is the right line B M, by the definition of a verſed ſine, which is by the falling of their perpendiculer H M V, vpon the Diameter B D, by the foreſited place; alſo the verſed ſine of the arch B C, the thrid ſide is the right line B P, by letting fall the perpendiculer K P L, vpon the Diameter B D.

Now the right lines H V, L K, and R G, are Paralels by the 38 of the firſt of *Pitiſcus*. and alſo by the worke. Then by the 39 th of the ſame, and alſo by 28 of the 6.th of *Ramus*. *If right Lines be cut jointly by many Paralell right lines, their Interſegments are proportionoll one to another.* But the right line M S, (the difference of the verſed ſines of the ſumme, and of the difference of the including ſides A B, and A C) as alſo G H, [the Parallel of Altitude [which may bee put to repreſent the Diameter of the Circle given. Though it be the Diameter of the Almicanter, which if it bee the Point C, devideth it into two verſed ſines. *viz.* C G, and C H] are Ioyntly cut by the foreſaid Parallels. Therefore I ſay the interſegments of the right lines M S, and G H, are proportionall one to another, that is as M S, the interſegment. of the Parallels V H, and G R [which is alſo the difference of the verſed ſines of the ſumme, and of the difference of

the

the two including ſides A B, and A C] is to G H, the other interſegment of the ſame Parallels V H, and G R [which is alſo the Diameter] ſo is M P, the interſegment of the Parallels V H, and K L, [which is the difference of the verſed ſines of the third ſide B C, and of B H, the difference of the two including ſides A B, and A C] to H C, the other interſegment of the ſame Parallels [which is the verſed ſine of the angle C A B] which was to bee demonſtrated.

Now I ſhall onely Illuſtrate the worke by *Numbers* and ſo proceed to the vſe of the backſide of this Quadrant; therefore I ſay let the Spherical triangle A B C bee given againe, whoſe ſides A B, A C, and B C, are knowne, *viz.* A B, 30 gr. A C 50 gr. and B C 70. and let it bee required [as before] to find the Angle, C A B, obſerue the Worke.

Summe B G -- 80, *the Verſed ſine* B S, 82635

The two including Sides — A C - 50, A B - 30 } *The third ſide* B C, *70 gr. the verſed ſine* } B P, 65798

Difference B H - 20, *the Verſed ſine* B M, 06031

The Difference of B M, and B S, *is* M S, 76604

The Difference of B M, and B P, *is* M P, 59767

As M S — 76604, *to* G H — 200000
So is M P — 59767, *to* C H — 156041

Which

hich right line *C H*, is the verſed ſine of the angle *A B*, 124 gr. 05 min. the Suns *Azimuth* from the North part of the Meridian. So now I ſuppoſe the firſt art of the *Axiome*, that I have laid downe is ſufficiently roved; and for the ſecond part it is nothing but the Converſe of the firſt, and the proportion is Changed hus, as the ſecond terme is to the firſt, ſo is the fourth erme to the third.

CHAP. V.

Of the Vſe of the back-ſide of this Quadrant.

THe generall vſe of the back-ſide of this Quadrant, is to Reſolue *Sphericall Triangles* that are agreeable to the Axieme in the Chapter afore-going, which reſolueth theſe two Caſes, firſt, three ſides being given to find an Angle; ſecondly, two ſides and the angle included, to find the third ſide. But here note, that if the difference of any two ſides exceed 90 gr. you cannot reſolue that Triangle without you convert the degres on the Inſtrument, *viz.* Number the differenee from the Center on the double Radius, and the Summe on the ſingle Radius, increaſing of the degrees from 90 backward. But in all Sphericall Triangles that you neede to reſolue for the finding the Houre, or Azimuth, the Sun muſt be viſible and not vnder the Horizon; therefore you haue two ſides *viz.* the Co-latitude and the Co-altitude, each of them not exceeding 90 gr. and it is plaine that if a Sphericall Triangle haue two ſides, each of them not exceeding 90

gr. the

gr. the difference of any two ſides of that Triangle is e
force, leſſe then 90 deg. therefore I ſay the Inſtrumen
is generall for the finding the Houre and Azimuth i
all Lattitudes, which is the chiefe aime intended. Theſe
things being premiſed I ſhall proceed to the working o
this Axiome vpon the *Inſtrument.*

Then I ſay, let the former Sphericall Triangle A B C
be given againe, the ſide A B. 30 gr. A C. 50 gr. B C
70 gr. and let the angle C A B be ſought for. Now
the Summe of the two including ſides A B, and A C,
is 80. gr. and their difference 20 gr. the ſumme I Num-
ber on the double Radius, which reacheth to the Point
A, the difference I Number on the ſingle Radius, which
reacheth to the point B, I apply the thrid to theſe two
Points or draw the line A B, and at the other end of
the Parallel of the verſed ſine of 80 gr. I note the point
C, on the ſingle Radius, then I note the verſed ſine of
the third ſide 70 gr. in the point R, on the ſingle Radius.
Now this Parallel of the third ſide 70. gr. interſecteth
the line A B in the point E. Now ſay, I have two plaine
triangles vponthe Inſtrument A B C, and E B R equi-
angled, becauſe of the Common angle at B, and the
Parallels C A, and R E, therefore I ſay the ſides about
the equall angles are preportionall. By the fourth of
the firſt of *Pitiſcus*, and alſo by the ſeuenth of *Ramus*
Elm: 12.

Now then it is cleare, that as B C (the difference of the
verſed ſines of the ſum 80 d. and of the difference 20 d.)
is to C A [the Diameter] ſo is B R the difference of the
verſed ſines of the third ſide 70 gr and of the difference of
the two includers 20 deg.] to R E [the verſed ſine of the
angle 124 gr. 5 min. included between the two ſaid ſides)
Or contrarily, as A C to C B, ſo E R. to R B. the dif-
ference of the verſed ſines of the third ſide, and of the
difference of the two includers, which right line R B
being added, to B S the verſed ſine of the ſaid difference

you

you haue S R the verſed ſine of the third ſide 70 gr.

Now to the Chiefe thing intended, which is to find the houre and Azimuth in all Latitudes. Therfore the day of the Moneth being knowne, find the Suns declination by the ſecond *Probleme* of the third Chapter, and if the Sun haue South declination, adde it to 90. gr. if North ſubtract it, and ſo haue you the Suns Diſtance from the Pole.

PROB. I.

To find the houre of the Day.

FIrſt, having the Co-latitude and the Suns diſtance from the Pole, find their ſumme and difference (but if the Co-latitude be 38 gr. 30 m. you may find thoſe Numbers on the rectified Scale, by the 6 or 7. Probleme of the third Chapter.)

Secondly, take the Suns Co-altitude with the Quadrant.

Thirdly, apply the thrid to the Summe on the double *Radius*, and to the Difference on the ſingle Radius, and where the Parallel of the Co-altitude (taken in the Parallel of ſides) cutteth the thrid, there is the Houre of the day; amongſt the Paralels of Angles.

Example,

Being in the Latitude of 51. gr. 30. min. I would know the Houre of the day, when the Sun hath 20 gr. North declination, and 34 gr. 30 min. Altitude. I take the Co-latitude 38 gr. 30 min. and the Suns diſtance from the Pole 70 deg. & I find their ſumme to be 108 gr. 30 min. and their difference 31 gr. 30 min. So now I apply the thred to 108 gr. 30 min. on the double Radius, and to 31 gr. 30 min. on the ſingle Radius, and where the Parallel of 55 gr. 30 min. the Co-altitude (taken in the Parallels of ſides) cutteth the thrid, there,

gr. the difference of any two sides of that Triangle is e
force, lesse then 90 deg. therefore I say the Instrumen
is generall for the finding the Houre and Azimuth i
all Lattitudes, which is the chiefe aime intended. Thes
things being premised I shall proceed to the working o
this Axiome vpon the *Instrument.*

Then I say, let the former Sphericall Triangle A B C
be given againe, the side A B. 30 gr. A C. 50 gr. B C.
70 gr. and let the angle C A B be sought for. Now
the Summe of the two including sides A B, and A C,
is 80. gr. and their difference 20 gr. the summe I Num-
ber on the double Radius, which reacheth to the Point
A, the difference I Number on the single Radius, which
reacheth to the point B, I apply the thrid to these two
Points or draw the line A B, and at the other end of
the Parallel of the versed sine of 80 gr. I note the point
C, on the single Radius, then I note the versed sine of
the third side 70 gr. in the point R, on the single Radius.
Now this Parallel of the third side 70. gr. intersecteth
the line A B in the point E. Now say, I have two plaine
triangles vpon the Instrument A B C, and E B R equi-
angled, because of the Common angle at B, and the
Parallels C A, and R E, therefore I say the sides about
the equall angles are preportionall. By the fourth of
the first of *Pitiscus*, and also by the seuenth of *Ramus*
Elm: 12.

Now then it is cleare, that as B C (the difference of the
versed sines of the sum 80 d. and of the difference 20 d.)
is to C A [the Diameter] so is B R the difference of the
versed sines of the third side 70 gr and of the difference of
the two includers 20 deg.] to R E [the versed sine of the
angle 124 gr. 5 min. included between the two said sides)
Or contrarily, as A C to C B, so E R. to R B. the dif-
ference of the versed sines of the third side, and of the
difference of the two includers, which right line R B
being added, to B S the versed sine of the said difference

you

you haue S R the verſed ſine of the third ſide 70 gr.

Now to the Chiefe thing intended, which is to find the houre and Azimuth in all Latitudes. Therfore the day of the Moneth being knowne, find the Suns declination by the ſecond *Probleme* of the third Chapter, and if the Sun haue South declination, adde it to 90. gr. if North ſubtract it, and ſo haue you the Suns Diſtance from the Pole.

PROB. I.

To find the houre of the Day.

FIrſt, having the Co-latitude and the Suns diſtance from the Pole, find their ſumme and difference (but if the Co-latitude be 38 gr. 30 m. you may find thoſe Numbers on the rectified Scale, by the 6 or 7. Probleme of the third Chapter.)

Secondly, take the Suns Co-altitude with the Quadrant.

Thirdly, apply the thrid to the Summe on the double *Radius*, and to the Difference on the ſingle Radius, and where the Parallel of the Co-altitude (taken in the Parallel of ſides) cutteth the thrid, there is the Houre of the day; amongſt the Paralels of Angles.

Example,

Being in the Latitude of 51. gr. 30. min. I would know the Houre of the day, when the Sun hath 20 gr. North declination, and 34 gr. 30 min. Altitude. I take the Co-latitude 38 gr. 30 min. and the Suns diſtance from the Pole 70 deg. & I find their ſumme to be 108 gr. 30 min. and their difference 31 gr. 30 min. So now I apply the thred to 108 gr. 30 min. on the double Radius, and to 31 gr. 30 min. on the ſingle Radius, and where the Parallel of 55 gr. 30 min. the Co-altitude (taken in the Parallels of ſides) cutteth the thrid, there,

I find 4 houres 00 min. (amongſt the parallels of Angles) if the obſervation be in the Afternoone, or 8 houres if it be in the Morning.

PROB. 2.

To find the Houre of Sun-riſing and Setting.

1. HAving the Co latitude and the Suns diſtance from the Pole, find their ſumme and difference.

2.ly, apply the thrid to the ſum on the double Radius, and to the difference on the ſingle Radius, and where the parallels of 90 degrees (taken in the parallel of ſides] cutteth the thrid, there is the houre of Sun riſing or Setting; amongſt the parallels of Angles.

Example,

Suppoſe the Co-latitude to be 38 gr. 30 min. the Suns diſtance from the Pole 70 gr. their Summe I find to be 108 gr. 30 min. and their Difference 31 gr. 30 min. then I apply the thrid to 108 gr. 30 min. on the double Radius, and to 31 gr. 30 min. on the ſingle Radius, and where the Parallel of 90 gr. [taken in the parallels of ſides] cutteth the thrid, there I find [amongſt the the Parallels of angles] 7 houres and 30 min. which is the time of Sun ſetting, and the Complement of that to 12 *viz.* 4 Houres 30 min. is his Riſing.

PROB. 3.

To find the Sunnes Azimuth.

FIrſt, take the Suns Co-altitude with your quadrant.

Scondly, having the Co-altitude and the Co-latitude, find their ſumme and difference.

Thirdly,

Thirdly, apply the thrid to the ſumme on the double Radius, and to the difference on the ſingle Radius, and where the parallel of the Suns diſtance from the Pole, [taken in Parallels of ſides] cutteth the thrid, there is the Suns Azimuth from the North, amongſt the Parallels of angles.

Example.

Let the Co latitude of the place bee 38 gr. 30 min. the Suns Co altitude 55 gr. 30 min. their ſumme is 94 gr. and their difference 17 gr. Then I apply the thrid to 94 on the double Radius, and to 17 gr. on the ſingle Radius; and where the Parallel of the Suns diſtance from the Pole 70 gr. [taken in the Parallels of ſides) cutteth the thrid, there I find amongſt the Parellels of angles, 101 gr. 30 min. the Suns Azimuth from the North.

PROB. 4.

To find the Sunnes Amplitude.

EXtend the thrid from the Latitude on the ſingle Radius through the center of the Rhumbus, and where the Parallel of the Suns diſtance from the Pole (taken in the Parallel of the ſides) cutteth the thrid, there is the Suns amplitude from the North, amongſt the Parallels of angles,

Example.

Let the latitude be 51 gr 30 min. the Suns diſtance from the Pole, 70, I extend the thrid from 51 gr. 30 min. on the ſingle Radius, through the center of the Rhumbus and where the parallel of the Suns diſtance from the Pole 70 gr. (taken in the parallels of ſides) cutteth the thrid there I find 56 gr. 30 min. amongſt the Parallels of angles, for the Sunnes amplitude from the North.

PROB. 5.

To find the Suns Height at any time aſſigned.

FIrſt, having the Co-latitude and the Sunnes diſtance from the Pole, find their Summe and Difference.

Secondly, apply the thrid to the ſumme on the double Radius, and to the Difference on the ſingle Radius, and where the Parallel of the time aſſigned (taken in the Parallels of angles] cutteth the thrid, there is the Co-altitude of the Sun at the time, amongſt the Paralels of ſides, whoſe Complement to 90 deg. is the height required.

Example.

Let the Co-latitude of the place be 38 gr. 30 min. the Suns diſtance from the Pole 70 gr. I would know his height at 6 of the clock, their ſumme I find to bee 108 gr. 30 min. and their Difference 31 gr. 30 min. Then I apply the thrid to 108 gr. 30 min. on the double Radius, and to 31 gr. 30 min. on the ſingle Radius, and where the Parallel of 6 of the clock, the time aſſigned [taken in the Parallels of angles] cutteth the thrid, there is the Co-altitude of the Sunne 74 gr. 30 min. amongſt the Parallel of ſides, whoſe Complement 15 gr. 30 min. is the height requited.

PROB. 6.

To find the Suns height when he comes to be due Eaſt *or* Weſt.

APply the thrid from the Co-latitude on the ſingle Radius, through the center of the *Rhumbus*, and where the Parallel of the Suns diſtance from the Pole

ole [taken in the Paralels of ſides) cutteth the thrid here is the Co-altitude, amongſt the Parallels of angles, whoſe Complement to 90 deg. is the height required.

Example.

Let the Co-latitude bee 38 gr. 30 min. the Suns iſtance from the Pole 70 gr. I would know his heighe when he comes to due Eaſt or Weſt; therefore I extend he thrid from 38 gr. 30 min. on the ſingle Radius, hrough the center of the *Rhumbus*, and where the Pa-allel of the Suns diſtance from the Pole 70 deg. (taken n the Parallel of ſides] cutteth the thrid, there is the Co altitude of the Sun 64 deg. 00 min. amongſt the Parallels of Angles, whoſe Complement 26 deg. 00 min. is the Suns height, when he comes to bee due Eaſt r Weſt.

PROB. 7.

To find the Latitude of a Place, the Suns Amplitude from the North, *with his Diſtance from the Pole being given.*

FIrſt, find the Suns Amplitude from the North amongſt the Parallels of angles, and likewiſe the Suns diſtance from the Pole in the Parallels of ſides, and note their Point of interſection.

Secondly, extend the thrid by this Point, and the center of the *Rhumbus*, and it will ſhew vpon the ſingle Radius the Latitude of the place.

Example.

I obſerue at *London*, the Suns amplitude from the North to be 56 gr. 30 min. when his diſtance from the Pole is 70 deg. Now I would know the Latitude of that place; therefore, I extend the thrid by the Point of

Interſection, and the center of the *Rhumbus*, and I find it to cut on the ſingle Radius, 51 deg. 30 min. the Latitude required.

PROB. 8.

To find the Declination of a Plane.

Firſt, draw on the Plane a line, Parallel to the Horizon.

Secondly, apply your Quadrant to this Horizontall line, ſo that the ſuperficies of the Quadrant bee Parallel to the Horizon.

Thirdly, holding vp a thrid and plummet to the outſide of the Limb, let the ſhade of the thrid paſſe by the Center of the quadrant, and note the degrees intercepted, betwixt the Ray of the quadrant that is perpendiculer to the Plane, and the ſhade of the thrid; which is the Suns *Azimuth* from the perpendiculer of the Plane: Alſo, you muſt note, whether the perpendiculer be to the Eaſtward or Weſtward of the ſhade of the thrid.

Fourthly, at the ſame Inſtant, take the Suns Altitude, that ſo you may find the Suns Azimuth from the South, by the third *Probleme* of this Chapter.

Fifthly, compare theſe Arches together, and if the Sunne be on the ſame ſide of the Meridian that the perpendiculer is from the ſhade, adde theſe two Arches together, gives the Declination of the Plane, of the ſame, Denomination of them both: But if the Sunne be not of the ſame ſide of the Meridian, that the perpendiculer is from the ſhade, ſubtract the leſſer from the greater, and the Remainer is the Declination of the Plane, of the ſame Denomination of the greater Arch.

As

As for Example.

The Sunnes Azimuth from the { *Perpendiculer of the Plane*, —— 50 d. 30 m. E.
South, —— 44 d. 15 m. W.

The Declinat. of the Plane, 94 d. 45 m. E.

The Sunnes Azimuth from the { *Perpendiculer of the Plane*, —— 50 d. 30 m. E.
South, —— 44 d. 15. m. W.

The Declination of the Plane, 06 d. 15 m. E.

The Sunnes Azimuth from the { *Perpendiculer of the Plane*, —— 50 d. 30 m. W.
South, —— 44 d. 15 m. E.

The Declinat. of the Plane, 06 d. 15 m. W.

FINIS.

Errata.

PAge 14, line last read, to the degree. Pag. 15 line 22 read 30 min. on the Limb. Pag. 16 l. 35, read 11 deg. 15 min. Pag. 22 li. 26 read Verticall angle. Pag. 25. li. 11 read D B 23 $\frac{1}{10}$. Pag. 29. li. 24 r 5th. Pag. 30 line 17, 18, 19, 20, read Deg. Pa. 32 l. 20 r. now I say. Pag. 29 line 13 for their, read the, Pa. 32 l. 19 for now this, r. which. Pag. ibid. line 24, for 4th r. 46.